main

October 20, 2019

[1]:
```
# A class to get the sentences from the dataset
class SentenceGetter(object):

    def __init__(self, data):
        self.n_sent = 1
        self.data = data
        self.empty = False
        aggregate_function = lambda s : [(w, t)
                                         for w, t in zip(s["Word"].values.
 ↪tolist(),
                                                         s["Tag"].values.
 ↪tolist())]
        self.grouped = self.data.groupby("Sentence #").apply(aggregate_function)
        self.sentences = [s for s in self.grouped]

    def getNext(self):
        try:
            s = self.grouped["{}".format(self.n_sent)]
            self.n_sent += 1
            return s
        except:
            print("Exception")
            self.empty = True
            return None
```

[2]:
```
import pandas as pd
import numpy as np

# read the annotated dataset from kaggle
data = pd.read_csv("CADEC.csv")
data = data.fillna(method="ffill")
#data.tail(10)

l_words = list(set(data["Word"].values))
n_words = len(l_words)

l_tags = list(set(data["Tag"].values))
```

```
n_tags = len(l_tags)

sentence_getter = SentenceGetter(data)
l_sentences = sentence_getter.sentences

# Prepare the data
n_max_seq_size = 75
d_words_to_index = {word: index + 1 for index, word in enumerate(l_words)}
d_tags_to_index = {tag: index for index, tag in enumerate(l_tags)}
```

[3]:
```
# preparing training and test data sets
import warnings
warnings.filterwarnings('ignore')
from keras.preprocessing.sequence import pad_sequences
from keras.utils import to_categorical
from sklearn.model_selection import train_test_split

X = [[d_words_to_index[word[0]] for word in sentence] for sentence in␣
 ↪l_sentences]
X = pad_sequences(maxlen=n_max_seq_size, sequences=X, padding="post",␣
 ↪value=n_words-1)

y = [[d_tags_to_index[word[1]] for word in sentence] for sentence in␣
 ↪l_sentences]
y = pad_sequences(maxlen=n_max_seq_size, sequences=y, padding="post",␣
 ↪value=d_tags_to_index["O"])

# changing the y-labels to categorical for training purposes
y = [to_categorical(idx, num_classes=n_tags) for idx in y]

# Split in Training and Test sets
X_tr, X_te, y_tr, y_te = train_test_split(X, y, test_size=0.1)
```

```
Using TensorFlow backend.
```

[4]:
```
# Now fitting a LSTM-CRF network with an embedding layer
from keras.models import Model, Input
from keras.layers import LSTM, Embedding, Dense, TimeDistributed, Dropout,␣
 ↪Bidirectional
from keras_contrib.layers import CRF

model_input = Input(shape=(n_max_seq_size,))

model = Embedding(input_dim = n_words + 1,
                  output_dim = 20,
                 input_length = n_max_seq_size,
                  mask_zero = True)(model_input)  # 20-dim embedding#
```

```python
model = Bidirectional(LSTM(units=50,
                           return_sequences=True,
                           recurrent_dropout=0.1))(model)     # variational␣
 ↪biLSTM

model = TimeDistributed(Dense(50, activation="relu"))(model)  # a dense layer␣
 ↪as suggested by neuralNer

crf = CRF(n_tags) # CRF layer
out = crf(model)  # output

model = Model(model_input, out)
model.compile(optimizer="rmsprop", loss=crf.loss_function, metrics=[crf.
 ↪accuracy])
model.summary()

history = model.fit(X_tr,
                    np.array(y_tr),
                    batch_size=32,
                    epochs=5,
                    validation_split=0.1,
                    verbose=1)
hist = pd.DataFrame(history.history)
```

```
WARNING:tensorflow:From /Users/aditya/opt/anaconda3/envs/mer/lib/python3.7/site-
packages/keras/backend/tensorflow_backend.py:74: The name tf.get_default_graph
is deprecated. Please use tf.compat.v1.get_default_graph instead.

WARNING:tensorflow:From /Users/aditya/opt/anaconda3/envs/mer/lib/python3.7/site-
packages/keras/backend/tensorflow_backend.py:517: The name tf.placeholder is
deprecated. Please use tf.compat.v1.placeholder instead.

WARNING:tensorflow:From /Users/aditya/opt/anaconda3/envs/mer/lib/python3.7/site-
packages/keras/backend/tensorflow_backend.py:4138: The name tf.random_uniform is
deprecated. Please use tf.random.uniform instead.

WARNING:tensorflow:From /Users/aditya/opt/anaconda3/envs/mer/lib/python3.7/site-
packages/keras/backend/tensorflow_backend.py:133: The name
tf.placeholder_with_default is deprecated. Please use
tf.compat.v1.placeholder_with_default instead.

WARNING:tensorflow:From /Users/aditya/opt/anaconda3/envs/mer/lib/python3.7/site-
packages/keras/backend/tensorflow_backend.py:3445: calling dropout (from
tensorflow.python.ops.nn_ops) with keep_prob is deprecated and will be removed
in a future version.
Instructions for updating:
```

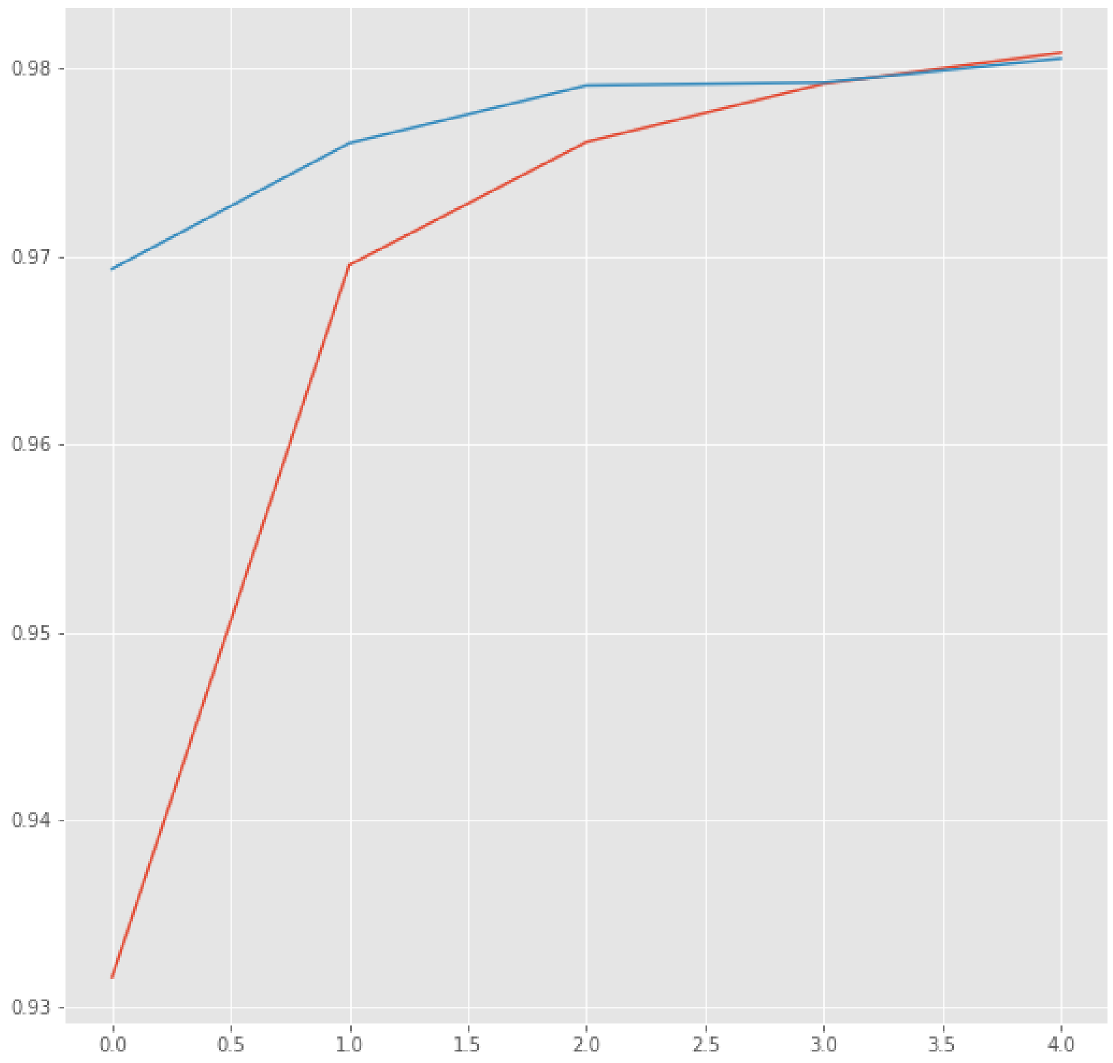
```
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 -
keep_prob`.
WARNING:tensorflow:From /Users/aditya/opt/anaconda3/envs/mer/lib/python3.7/site-
packages/keras/backend/tensorflow_backend.py:2974:
add_dispatch_support.<locals>.wrapper (from tensorflow.python.ops.array_ops) is
deprecated and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /Users/aditya/opt/anaconda3/envs/mer/lib/python3.7/site-
packages/keras/optimizers.py:790: The name tf.train.Optimizer is deprecated.
Please use tf.compat.v1.train.Optimizer instead.


_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_1 (InputLayer)         (None, 75)                0
_________________________________________________________________
embedding_1 (Embedding)      (None, 75, 20)            166560
_________________________________________________________________
bidirectional_1 (Bidirection (None, 75, 100)           28400
_________________________________________________________________
time_distributed_1 (TimeDist (None, 75, 50)            5050
_________________________________________________________________
crf_1 (CRF)                  (None, 75, 11)            704
=================================================================
Total params: 200,714
Trainable params: 200,714
Non-trainable params: 0
_________________________________________________________________
WARNING:tensorflow:From /Users/aditya/opt/anaconda3/envs/mer/lib/python3.7/site-
packages/keras/backend/tensorflow_backend.py:986: The name tf.assign_add is
deprecated. Please use tf.compat.v1.assign_add instead.

Train on 6091 samples, validate on 677 samples
Epoch 1/5
6091/6091 [==============================] - 103s 17ms/step - loss: 0.2430 -
crf_viterbi_accuracy: 0.9316 - val_loss: 0.1013 - val_crf_viterbi_accuracy:
0.9693
Epoch 2/5
6091/6091 [==============================] - 84s 14ms/step - loss: 0.0911 -
crf_viterbi_accuracy: 0.9695 - val_loss: 0.0768 - val_crf_viterbi_accuracy:
0.9760
Epoch 3/5
6091/6091 [==============================] - 88s 14ms/step - loss: 0.0696 -
crf_viterbi_accuracy: 0.9761 - val_loss: 0.0653 - val_crf_viterbi_accuracy:
0.9791
Epoch 4/5
6091/6091 [==============================] - 83s 14ms/step - loss: 0.0567 -
```

```
crf_viterbi_accuracy: 0.9792 - val_loss: 0.0581 - val_crf_viterbi_accuracy:
0.9793
Epoch 5/5
6091/6091 [==============================] - 78s 13ms/step - loss: 0.0485 -
crf_viterbi_accuracy: 0.9809 - val_loss: 0.0508 - val_crf_viterbi_accuracy:
0.9805
```

[7]:
```
import matplotlib.pyplot as plt
plt.style.use("ggplot")
plt.figure(figsize=(10,10))
plt.plot(hist["crf_viterbi_accuracy"])
plt.plot(hist["val_crf_viterbi_accuracy"])
plt.show()
```



[9]:
```
# Evaluation
from seqeval.metrics import precision_score, recall_score, f1_score,␣
↪classification_report

test_pred = model.predict(X_te, verbose=1)
d_index_to_tags = {i: w for w, i in d_tags_to_index.items()}

def pred2label(pred):
    out = []
    for pred_i in pred:
        out_i = []
        for p in pred_i:
            p_i = np.argmax(p)
            out_i.append(d_index_to_tags[p_i].replace("PAD", "O"))
        out.append(out_i)
    return out

pred_labels = pred2label(test_pred)
test_labels = pred2label(y_te)
print("F1-score: {:.1%}".format(f1_score(test_labels, pred_labels)))
print(classification_report(test_labels, pred_labels))
```

```
752/752 [==============================] - 3s 5ms/step
F1-score: 54.8%
           precision    recall  f1-score   support

      ADR       0.51      0.53      0.52       523
     Drug       0.80      0.72      0.76       195
  Disease       0.00      0.00      0.00        32
  Symptom       0.00      0.00      0.00        29
  Finding       0.00      0.00      0.00        34

micro avg       0.59      0.52      0.55       813
macro avg       0.52      0.52      0.52       813
```

[16]:
```
# Trying some predictions
idx = 120
p = model.predict(np.array([X_te[idx]]))
p = np.argmax(p, axis=-1)
true = np.argmax(y_te[idx], -1)
print("{:15}||{:5}||{}".format("Word", "True", "Pred"))
print(30 * "=")
for w, t, pred in zip(X_te[idx], true, p[0]):
    if w != 0:
        print("{:15}: {:5} {}".format(l_words[w-1], l_tags[t], l_tags[pred]))
```

```
Word           ||True ||Pred
==============================
loss           : B-ADR B-ADR
of             : I-ADR I-ADR
muscel         : I-ADR I-ADR
strength       : I-ADR I-ADR
,              : O     O
vertigo        : B-ADR B-ADR
caused         : O     O
by             : O     O
cramping       : B-ADR B-ADR
neck           : I-ADR I-ADR
muscels        : I-ADR I-ADR
,              : O     O
loss           : B-ADR B-ADR
of             : I-ADR I-ADR
sexual         : I-ADR I-ADR
drive          : I-ADR I-ADR
,              : O     O
hair           : O     B-ADR
,              : O     O
short          : O     B-ADR
term           : O     I-ADR
memory         : O     I-ADR
,              : O     O
zombie         : B-ADR B-ADR
like           : I-ADR I-ADR
doped          : I-ADR I-ADR
up             : I-ADR I-ADR
state          : I-ADR I-ADR
,              : O     O
halucinations  : B-ADR B-ADR
during         : I-ADR O
day            : I-ADR O
,              : O     O
unable         : B-ADR B-ADR
to             : I-ADR I-ADR
walk           : I-ADR I-ADR
for            : I-ADR O
2              : I-ADR O
weeks          : I-ADR O
,              : I-ADR O
get            : I-ADR O
out            : I-ADR O
of             : I-ADR I-ADR
bed            : I-ADR I-ADR
et             : O     I-ADR
al             : O     I-ADR
```

```
reduced        : B-ADR I-ADR
mental         : I-ADR I-ADR
capabiities    : I-ADR I-ADR
,              : O     O
depression     : B-ADR B-ADR
excessive      : B-ADR I-ADR
sleep          : I-ADR I-ADR
requirements   : I-ADR I-ADR
and            : O     O
more           : O     O
that           : O     O
i              : O     O
can            : O     O
not            : O     O
remember       : O     O
0              : O     O
sexual         : O     O
sexual         : O     O
sexual         : O     O
sexual         : O     O
sexual         : O     O
sexual         : O     O
sexual         : O     O
sexual         : O     O
sexual         : O     O
sexual         : O     O
sexual         : O     O
sexual         : O     O
sexual         : O     O
```

[22]:
```
# Prediction on new sentence
test_sentence = ["I", "was", "suffering", "with", "chronicle", "headaches",␣
↪"took",
                 "crocin", "for", "relieving", "pain"]
x_test_sent = pad_sequences(sequences=[[d_words_to_index.get(w, 0) for w in␣
↪test_sentence]],
                            padding="post", value=0, maxlen=n_max_seq_size)
p = model.predict(np.array([x_test_sent[0]]))
p = np.argmax(p, axis=-1)
print("{:15}:{}".format("Word", "Prediction"))
print("="*26)
for w, pred in zip(test_sentence, p[0]):
    print("{:15}:  {:5}".format(w, l_tags[pred]))
```

```
Word           :Prediction
==========================
I              :  O
was            :  O
```

```
suffering      :  O
with           :  O
chronicle      :  B-Drug
headaches      :  B-ADR
took           :  O
crocin         :  B-Drug
for            :  O
relieving      :  B-ADR
pain           :  I-ADR
```

```
[ ]:
```